

Using Supply Chain Operation Reference Model and Failure Mode and Effect Analysis to Measure Delivery Performance of a Distribution System (Case Study: Lotte Mart Indonesia)*

Syarif Hidayat, Sita Ayu Astrellita**

Department of Industrial Engineering, Faculty of Science and Technology,
University of Al Azhar Indonesia, Jl. Sisingamangaraja, Jakarta, 12110

** penulis untuk korespondensi: sita.ayu.astrellita@gmail.com

Abstract – This research was conducted to identify the supply chain model of PT. Lotte Mart Indonesia (LMI) and analyze the performance of its cross dock distribution system using the adjusted Supply Chain Operation Reference (SCOR) model. The products studied were the fastest moving drinks and dairy category. The first level of performance indicator for Reliability attribute is Perfect Order Fulfillment which has the second level of performance indicators are % of Orders Delivered in Full, and On Time Delivery. The supply chain performance for 3 months in 2012 was good at 74%. The second level mapping found errors in the deliver stock (D1) and deliver retail (D4) procedures. The third level mapping found 4 erroneous procedures in the stock-out goods, receiving inappropriate order, delayed and damaged goods, and a gap between ordered and received goods. Procedures were suggested to remedy these errors.

Keywords - supply chain performance, SCOR, Fishbone diagram, FMEA

I. INTRODUCTION

The growth of retail business in Indonesia still show bright prospect in the future. Its growth ranging between 13-15% for 2011 [1]. In 2012, there were more than two million retail stores in Indonesia, from traditional shops to hypermarkets

[2]. In a highly competitive business environment, companies are required to meet increasingly complex customer demands. To meet these demands, interrelated companies in a supply chain must work in synergy in a close supply chain management system (SCM). A company must have leading competitive advantage against similar industry in order to seize the market share and profit.

The most important job in SCM is to control the physical flow. With high variation and the amount of customer demand, the company is required to be more responsive and to meet the needs efficiently. There are several strategies to response to the demand, from product planning level until the strategy that involves all the companies in the supply chain. One of the strategies is cross docking. Cross docking is a good method to reduce inventory and increase customer satisfaction [3].

One of the companies that has implemented the SCM concept is PT. Lotte Mart Indonesia (LMI). LMI also has implemented cross docking strategy to meet with fluctuative customer demands and keep trying to increase the service. Currently LMI does not have a solid comprehensive performance measurement system. The performances are just measured functionally and the output without using the performance measurement system to control supply chain performance, so it is not known certainly whether the distribution system is effective or not.

Supply Chain Operation Reference Model (SCOR Model) is employed to measure the delivery performance of the company. Following the

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background above, the research questions proposed here is “how is the supply chain model at LMI structured and what is the performance when measured using SCOR approach?”

II. BASIC THEORY

2.1 Supply Chain Management

A supply chain is a network of companies that work together to create and deliver products to end-user. The companies are supplier, manufacturer, distributor, store or retail, and other company like logistic company [4].

Supply chain management is an approach in integrating various organizations that organize procurement or distribution, namely supplier, manufacturer, warehouse, and store so that the goods can be produced and distributed in the right quantity and location, on time, and minimize cost when satisfy the customer [5].

2.2 Cross Dock

A simple definition of cross-docking is as followings: receiving product from a supplier or manufacturer for several end destination and consolidating this product for common final delivery destinations [6]. The key to the process is trans-shipping. Equally important is the process of turning expensive delivery consignments into economic loads through consolidation and resource sharing. For many businesses it is essential to keep track of product consignments as they progress along the supply chain. The key benefits of cross-docking techniques are improvements in service levels, inventory levels, stocking returns and unit costs.

2.3 Supply Chain Operations Reference Model (SCOR Model)

SCOR Model was developed by the Supply Chain Council (SCC). SCOR is a reference process model that incorporates the concepts in business process reengineering, benchmarking and process measurement [4]. There are five major supply chain processes, namely plans, make, source, deliver and return. SCOR model provides guidance on the types of metrics used to measure the performance of a company. Mapping stages in SCOR are divided into four levels, those are [7].

1. Level 1, defines the scope and content of the SCOR Model. At this stage the performance targets for the company to compete are set.
2. Level 2, which is a continuation of the analysis of level 1, the configuration stage of the supply chain processes that exist.
3. Level 3 continues the analysis of level 2, the decomposition stage of the processes that exist in the supply chain into elements that define the company's ability to compete.
4. Level 4, the implementation phase of the mapping programs as well as defining specific application behaviors to achieve competitive advantage and to adapt to changing business conditions.

2.4 Analytical Hierarchy Processing (AHP)

AHP is a multi-criteria decision-making approach [8].

The AHP is a decision support tool which can be used to solve complex decision problems [9]. It is a structured method to elicit preference opinion from decision makers. It uses a multi-level hierarchical structure of objectives, criteria, subcriteria, and alternatives. The pertinent data are derived by using a set of pairwise comparisons. These comparisons are used to obtain the weights of importance of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion.

The AHP approach was developed in response to military contingency planning, scarce resources allocation, and the need for political participation in disarmament agreements [10]. All these problems rely heavily on measurement and tradeoff of intangibles in a multi-criteria process.

2.5 Fishbone diagram

The fishbone diagram analyse is a tool for analyzing the business process and its effectiveness. It is also commonly referred as “Ishikawa Diagram” because it was invented and incorporated by Kaoru Ishikawa, a Japanese quality control statistician [11]. It is defined as a fishbone because of its structural outlook and appearance. In normal stature it looks like a skeleton of a fish. The fishbone diagram and analysis typically evaluates the causes and sub-causes of one particular problem and therefore assists to uncover all the symptoms of any business problem, hence the name “Cause-Effect analysis”.

Figure 1 shows a typical Fishbone diagram. The effect is usually a problem needs to be resolved, and is placed at the "fish head". The causes of the effect are then laid out along the "bones", and classified into different types along the branches [12].

2.6 Failure Mode and Effect Analysis (FMEA)

FMEA is a widely used evaluation method for both the automobile industry and other organizations employing Six Sigma techniques and problem solving approaches [13]. Properly applied, an FMEA can be a useful tool in organizing and pinpointing areas of highest concern and then for focusing effort and documenting results. The basic steps are to identify the root process, list potential problems that could occur, rate the failure mode for severity, occurrence, and detectability, and then derive a Risk Priority Number (RPN) which can direct design or improvement effort to the areas of greatest concern. Actions are then undertaken to reduce the risk presented by the failure mode.

III. RESEARCH METHODOLOGY

The study was conducted at PT. Lotte Mart Indonesia which was focused on the Distribution Center (DC), LMI Headquarter, and Lotte Mart Ratu Plaza branch that acted as a store. The study was conducted in March-April 2012. Figure 2 shows the research flowchart.

IV. RESULT AND DISCUSSION

The supply chain involving LMI is shown on Figure 3. It depicts the flow of goods from the suppliers to the Distribution Center (DC) as the response to the orders; and the continuing flow from the DC to the requesting stores.

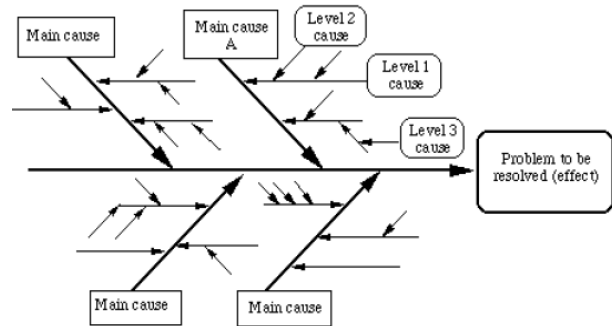


Figure 1. Typical Fishbone diagram

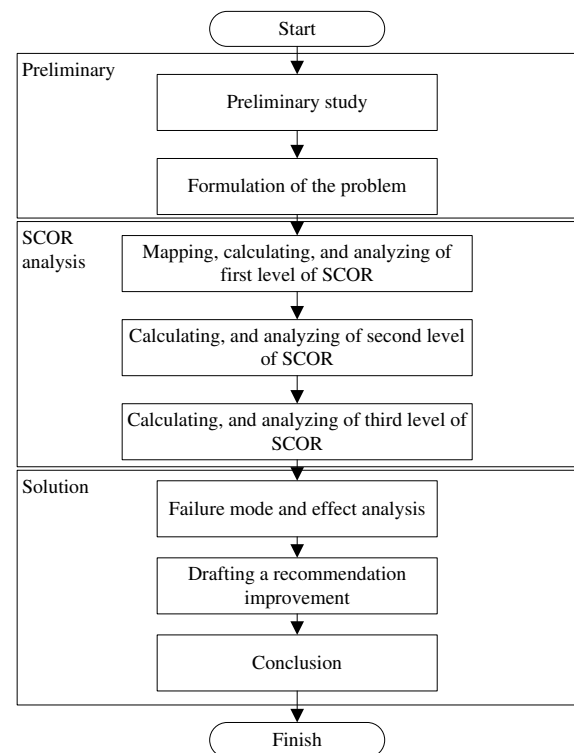


Figure 2. Research flowchart [14]

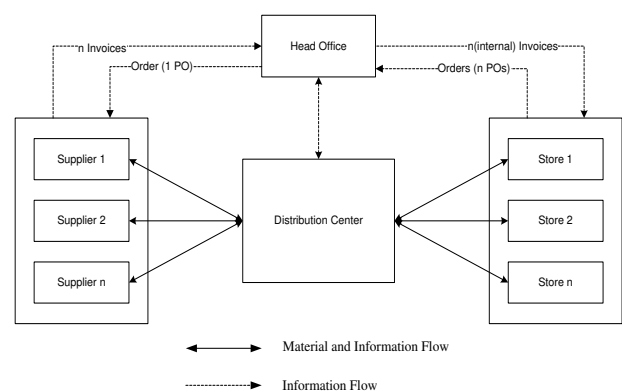


Figure 3. Flow of goods at LMI

4.1 Selection of Research Objects

The object of research in this study was the fastest moving products of PT. Nestle Indonesia. As the first step, the researchers accessed the Sales Database to review the total sales by category of products that used the cross dock facility. Figure 4 shows the result.

The chart shows that the greatest contribution of sales is given by category number 12, which is the dairy and drinks. For the second step, the researchers identified the vendors for this category. Figure 5 shows the result. There were 10 drinks and milk vendors who used the Cross Dock facility, and PT. Nestle Indonesia has the highest total sales.

4.2 SCOR Level 1 Performance Measurement

At LMI the main objectives of the business is defined as:

1. To provide the best level of services to the customers
2. To increase corporate profits

The achievements of these objectives were measured using specific SCOR models, namely Reliability, Responsiveness, and Cost/Asset. The first objective could be measured by analyzing the value of two indicators, namely Reliability, and Responsiveness. The second objective could be measured by analyzing the value of two indicators, namely supply chain costs and asset management efficiency. Due to the limitations of data access only two indicators were measured, namely Reliability, and Responsiveness.

Supply chain management at LMI includes only 4 SCOR processes, i.e. plan, source, deliver, and return. As a retail company LMI does not have Make process. Figure 6 shows the first level map of SCOR concept.

The framework to measure the supply chain performance at LMI is shown in Figure 7.

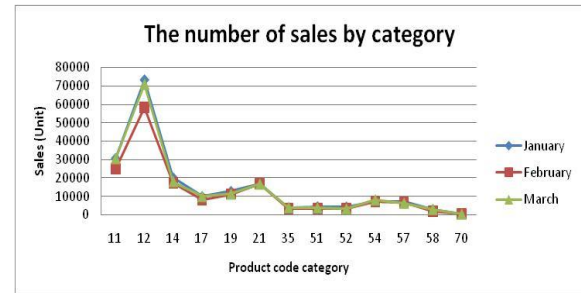


Figure 4. The number of sales by product category [14]

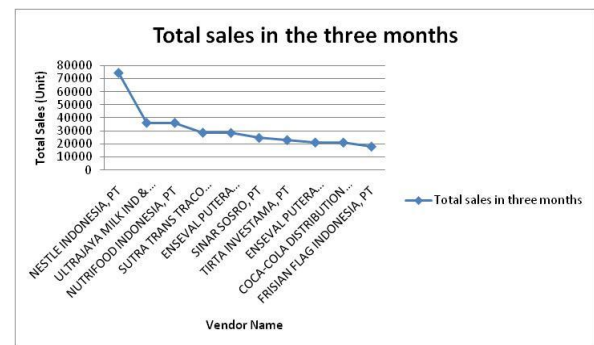


Figure 5. Total sales in three month for top 10 vendors [14]

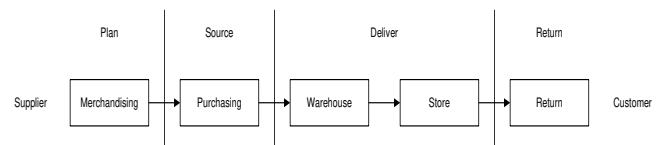


Figure 6. First level mapping [14]

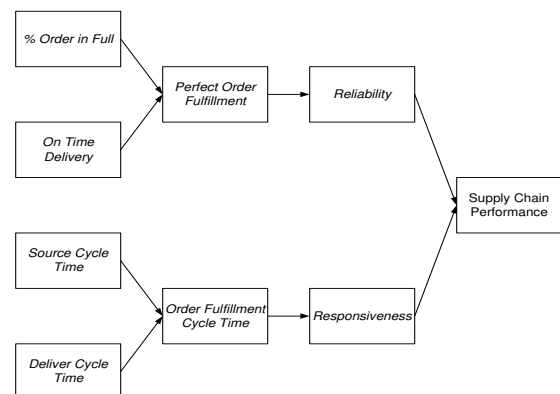


Figure 7. framework of supply chain performance measurement SCOR-based system to LMI [14]

Table 1 shows the model to measure the LMI supply chain performance based on SCOR.

Table 1. Performance measurement model [14]

No	SCOR		Lotte Mart Store		Adjustment need to be done
	Indicator for Level-1	Indicator for Level-2	Indicator for Level-1	Indicator for Level-2	
1	Perfect order fulfillment	% of ordered delivered in full	Perfect Order Fulfillment	% of ordered delivered in full	PT LMI = SCOR
		Delivery performance to customer committ date		On-time delivery	Delivery performance indicator to customer commit date is named On-time delivery
		Document accuracy			For above 2 indicators, only accurate documents are counted.
		Perfect condition			For above 2 indicators, only goods in good conditions are counted. Damaged and substandard goods
2	Order fulfillment cycle times	Source cycle-time	Order Fulfillment cycle-time	Source cycle-time	PT LMI = SCOR
		Make cycle-time			PT LMI is not a manufacturing coy, so it does not have "make" indicator
		Deliver cycle-time		Deliver cycle-time	PT LMI = SCOR

4.3 Determining the importance of the performance using AHP approach.

Based on the description above, it is necessary to the existing weight values calculated by using pairwise comparison in AHP method and solved using Expert Choice software. 6 respondents (experts) involved are the Procurement Manager, Senior Merchandise Manager, Business/Data Analyst, Supply Chain & Logistics Manager, Store General Manager at Lotte Mart Ratu Plaza, and Section Head of Goods Receiving at Lotte Mart Ratu Plaza.

The inputs from the respondents are shown in Table 2 (comparing Reliability and Responsiveness) and Table 3 (% Order-in-full and On-time delivery).

Table 4 shows the result when running the inputs using Expert Choice software. It shows that On-time delivery ranks the highest while Responsiveness came second.

Tables 5 and 6 shows the supply chain performance of goods delivered by the supplier to the DC, and from the DC to the store. At 76%-77% the supplier performance looks better than the distribution center (DC) by the standard of [15]. However, LMI is still not satisfied with this performance. Therefore the study was continued with the analysis on the SCOR level 2 which are mapped in more detail at the ongoing process from supplier to store.

Table 2. Pairwise comparison matrix from 6 respondents on Reliability and Responsiveness

	Responden	Reliability	Responsiveness
Reliability	Responden 1	1	1
	Responden 2	1	3
	Responden 3	1	0,33
	Responden 4	1	1
	Responden 5	1	0,2
	Responden 6	1	1
Responsiveness	Responden 1	1	1
	Responden 2	0,33	1
	Responden 3	3	1
	Responden 4	1	1
	Responden 5	5	1
	Responden 6	1	1

Table 3. Pairwise comparison matrix from 6 respondents on % Order in full and On-time delivery

	Responden	% Order in Full	On Time Delivery
% Order in Full	Responden 1	1	1
	Responden 2	1	0,2
	Responden 3	1	0,14
	Responden 4	1	0,2
	Responden 5	1	3
	Responden 6	1	1
On Time Delivery	Responden 1	1	1
	Responden 2	5	1
	Responden 3	7	1
	Responden 4	5	1
	Responden 5	0,33	1
	Responden 6	1	1

Table 4. End result using Expert Choice

Attribute	Weight
Reliability	0,43
Responsiveness	0,57
% Order in Full	0,34
On Time Delivery	0,66

Table 5. Supplier-DC Performance

Atribut					Bobot	Atribut Total			
Atribut	Periode 1	Periode 2	Periode 3	Target		Periode 1	Periode 2	Periode 3	Target
Reliability	65%	83%	68%	97%	0,43	28%	36%	30%	42%
Responsiveness	60%	100%	75%	100%	0,57	34%	57%	42%	57%
SUPPLY CHAIN PERFORMANCE						62%	92%	72%	99%
KONVERSI SUPPLY CHAIN						63%	94%	73%	100%

Table 6. DC-Stores Performance

Atribut					Bobot	Atribut Total			
Atribut	Periode 1	Periode 2	Periode 3	Target		Periode 1	Periode 2	Periode 3	Target
Reliability	49%	67%	57%	97%	0,43	21%	29%	25%	42%
Responsiveness	60%	100%	75%	100%	0,57	34%	57%	42%	57%
SUPPLY CHAIN PERFORMANCE						55%	86%	67%	99%
KONVERSI SUPPLY CHAIN						56%	87%	68%	100%

4.4 SCOR level 2

Figure 8 is the mapping diagram (thread diagram) to show the flow of material and information from suppliers to consumers. This mapping is also used to analyze the activities that are not well-connected (disconnect analysis), that makes the supply-chain performance bad.

From mapping above, it appears that the flow of information from DR1 and DR2 (Delivery Return) to the D1 and D4 (Delivery), and SR1 and SR2 (Source Return) to the S1 and S2 (Source) is connected so that it can happen that the delivery of goods should be returned but in the absence of information submitted, the goods are re-spins in the material flow so that goods can only move but do not generate revenue. Here is a proposed mapping of level 2. Figure 9 shows the suggested revision to the activity flow.

From the level 2 proposed mapping above, it is expected that the new information flow can decrease the cost of outdated items by proper treatment to goods which origin from the process of return by putting the plan of returns.

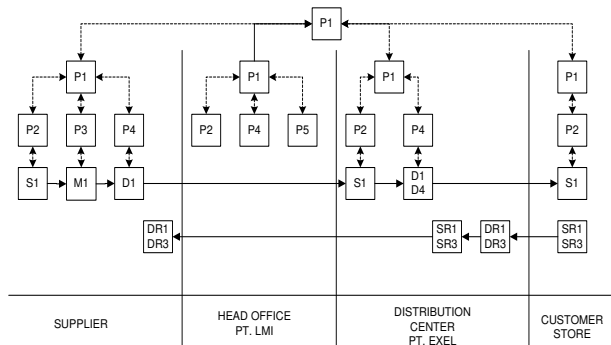


Figure 8. Second level mapping (as is)

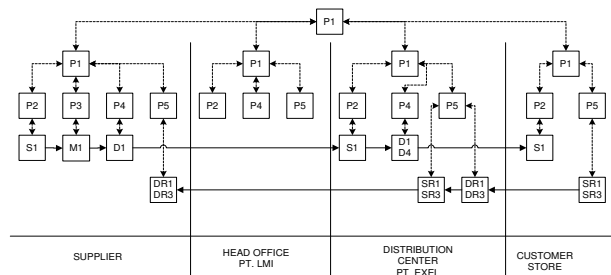


Figure 9. Second level mapping (suggested)

4.5 SCOR Level 3

Based on the details of business processes at level 2, problem found is the velocity of returned goods on the goods which are being returned, then the mapping of level 3 as in Attachment 1, is more focused on business processes of deliver stock product (D1) and deliver retail product (D4). After level 3 mapping is done, then the authors conducted interviews with experts on the processes that are risky. 4 processes were identified as problematic:

- problems that arise out of stock items from inventory and ordering process of determining the date of delivery (D1.3)
- issues of not delivered the goods in accordance with existing orders in the document that emerged from the entry of goods into the delivery vehicle and expenditure documentation (D1.11)
- delay in the arrival time of goods and the damaged of goods packaging arising from the delivery of goods issues (D1.12)
- problem of the gap between ordered goods, delivered goods, and availability of stocks listed on the system arising from acceptance and verification of goods in stores (D4.2).

When the processes that are problematic have been identified, the researchers then conducted interviews with the store managers at LMI to elaborate on the details.

4.6 Fishbone Diagram Analysis

From the interviews with LMI people the authors drew 4 fishbone diagrams, shown in Figures 10, 11, 12 and 13. The diagrams are for the following processes: Reserve inventory and determine delivery date; Load products to vehicle & generate shipping documents; Product shipping, and Goods receiving and verification.

4.7 Failure Mode and Effect Analysis (FMEA)

The fishbone diagrams in chapter 4.6 were further analyzed using FMEA. With FMEA the authors obtained the largest Risk Priority Number (RPN) then formulated a solution to the LMI. The authors took the largest three of the causes of the problem potentials. This is shown in Table 7.

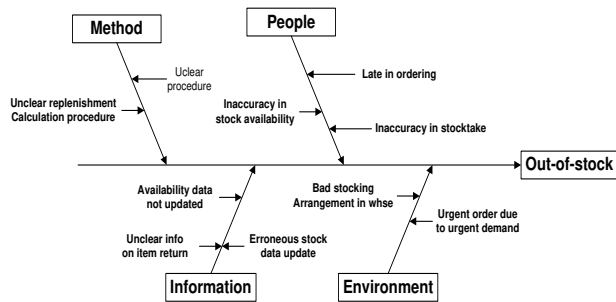


Figure 10. Fishbone diagram on reserve inventory & delivery date

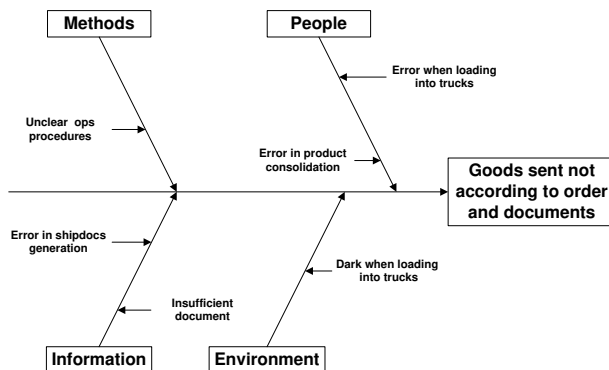


Figure 11. Fishbone diagram on load product and generate shipping documents

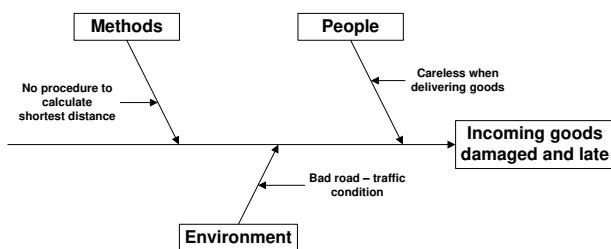


Figure 12. Fishbone diagram on product shipping

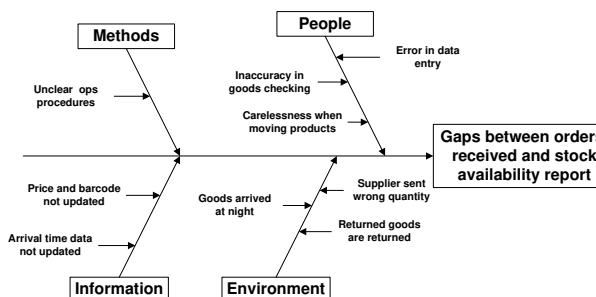


Figure 13. Fishbone diagram on goods receiving and verification at the warehouse

Table 7. Priority of potential causes of failure

Potential Effect(s) of Failure	Risk Priority Number (RPN)
Receipt back the return goods	336
There is no clear operational procedures	320
The lack of clear information concerning the return goods	315

Obviously the highest risk of failure came from the process of goods receiving, as has been indicated beforehand.

V. CONCLUSION

Based on research that has been done, it can be concluded, among others:

- From the results of performance measurement for 3 months (January, February, March 2012), based on the developed SRP performance measurement models, the average performance of DC for 3 months was 72-74%, which by Volby (2000), which falls into the category of good performance (between 70%-90%). However, LMI is still not satisfied with this performance, therefore the research was continued to lower SCOR level.
- In the second level of analysis, the problems are the deliver stock product (D1) and deliver retail product (D4), then performed the analysis of SCOR level 3, and obtained 4 problematic processes:
 - Problems of the stockout goods from the order process and decision of the delivery date (D1.3)
 - Inappropriate ordered goods on the document which appeared from the process of incoming goods to vehicle and outgoing delivery documentation (D1.11)
 - Delayed arrived goods and damaged arrived goods appeared from the delivery process (D1.12) and
 - The gap between ordered and arrived goods and availability stock which listed on the system appeared from the acceptance and goods verification at store (D4.2).

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ATTACHMENT

Attachment 1. Third level mapping

